WE CLAIM:

1. An alignment system for a lithographic apparatus, comprising:

a source of alignment radiation;

a detection system comprising a first detector channel and a second detector channel; and

a position determining unit in communication with said detection system,

wherein said position determining unit is constructed to process information from said first and second detector channels in a combination to determine a position of an alignment mark on a work piece, said combination taking into account a manufacturing process of said work piece.

2. An alignment system according to claim 1, wherein said first detector channel is a first non-zero-diffraction-order channel, and said second detector channel is a second non-zero-diffraction-order channel.

3. An alignment system according to claim 2, wherein said position determining unit is constructed to process said information from said first and second non-zero-diffraction-order channels by weighting first and second signals from said first and second non-zero-diffraction-order channels with factors that depend on a relative strength of said first signal to said second signal.

4. An alignment system according to claim 3, wherein the weight factor for said second non-zero-diffraction-order channel is set to zero when a strength of said first signal relative to said second signal exceeds a predetermined threshold.

5. An alignment system according to claim 1, wherein said position determining unit is constructed to process information from said first and second detector channels in a combination to determine a position of said alignment mark on said work piece with a first precision.

6. An alignment system according to claim 5, wherein said position determining unit is constructed to process information from third and fourth detector channels to determine a position of said alignment mark on said work piece with a second precision that is more precise than said first precision.

7. An alignment system according to claim 1, wherein said position determining unit is constructed to process said information from said first and second detector channels by weighting first and second signals from said first and second detector channels equally.

8. An alignment system according to claim 1, wherein said position determining unit is constructed to process said information from said first and second detector channels by weighting first and second signals from said first and second detector channels with factors that depend on at least one measurable quantity selected from the set of measurable quantities consisting of mcc, minirepro, signal-to-noise ratio, signal shape, signal envelope, focus, tilt, order channels position offset, wavelength channels position offset, shift between segments and coarse-fine position deviation,

wherein the parameter mcc is a multiple correlation coefficient indicating how well the measured signal resembles the signal expected for a perfect alignment mark, minirepro is a standard deviation of the aligned position of different sections or portions of an alignment measurement indicating the accuracy of the aligned position, signal to noise ratio is the fitted signal divided by the relative level of noise across the spectrum of the measured signal, while the signal shape is the relative level of a few discrete frequencies in this spectrum, generally at multiples of the base frequency, the

signal envelope is variance of the signal strength during the measurement, the focus is the offset in wafer height during the measurement, the tilt is the angle between the wafer angle and the detector angle during the measurement, order channels position offset is the measured difference in aligned position of the various channels of one wavelength, the wavelength channels position offset is the measured difference in aligned position of the various wavelength channels, the shift between segments is the measured difference in aligned position of the various segments of a multi segmented alignment mark, and the coarse-fine position deviation is the difference between the position of the alignment marks in the fine phase with respect to their expected position based on alignment mark measurements in the coarse phase.

9. An alignment system according to claim 1, wherein said position determining unit is constructed to determine said position of said alignment mark by a predictive recipe using said combined information from said first and second detector channels.

10. An alignment system according to claim 9, wherein said predictive recipe is a static predictive based on a fixed data set.

11. An alignment system according to claim 9, wherein said predictive recipe is based on an initial data set that may be modified during said determining said position of said alignment mark on said work piece.

12. An alignment system according to claim 10, wherein said fixed data set include a dependence of a position of said alignment mark on said work piece.

13. An alignment system according to claim 9, wherein said predictive recipe includes fitting a continuous function to at least said position of said alignment mark determined from combined information from said first and second detector channels.

14. An alignment system according to claim 9, wherein said predictive recipe predicts a position of an alignment mark with substantially zero systematic processing-induced error.

15. An alignment system according to claim 14, wherein said substantially zero systematic processing-induced error corresponds to systematic errors introduced by a chemical mechanical polishing process.

16. An alignment system according to claim 14, wherein said substantially zero systematic processing-induced error corresponds to systematic errors introduced by a copper damascene process.

17. An alignment system according to claim 1, wherein said position determining unit is constructed to determine said position of said alignment mark by including information from an alignment mark detected on a second work piece.

18. An alignment system according to claim 1, wherein said first detector channel is a first wavelength channel, and said second detector channel is a second wavelength channel.

19. An alignment system according to claim 1, wherein said source of alignment radiation comprises a laser providing illumination radiation at a first wavelength.

20. An alignment system according to claim 19, wherein said source of alignment radiation further comprises a second laser providing illumination radiation at a second wavelength.

21. An alignment system according to claim 1, wherein said source of alignment radiation comprises a broadband source adapted to provide illumination radiation at a plurality of wavelengths.

22. An alignment system according to claim 1, wherein said detection system comprises a first detector constructed to provide a first detection signal to said first detector channel, and a second detector constructed to provide a second detection signal to said second detector channel.

23. An alignment system according to claim 1, wherein said detection system is constructed to detect a first target of a multitarget alignment mark and a second target of said multitarget alignment mark.

24. An alignment system according to claim 23, wherein said first target of said multitarget alignment mark includes at least one of a structure above or below a portion of said first target.

25. An alignment system according to claim 23, wherein said detection system is constructed to detect a first target of a multitarget alignment mark to provide said first detection signal, and said detection system is constructed to detect a second target of said multitarget alignment mark to provide said second detection signal.

26. An alignment system according to claim 23, wherein said first target of said multitarget alignment mark is a process target that is constructed to undergo predetermined changes during said manufacturing process of said work piece.

27. An alignment system according to claim 26, wherein said second target of said multitarget alignment mark is constructed to undergo less changes during said manufacturing process of said work piece than said first target to provide a robust backup target to said first target.

28. An alignment system according to claim 23, wherein said first target of said multitarget alignment mark is a sacrificial target that is constructed to be destroyed during said manufacturing process of said work piece.

29. An alignment system according to claim 23, wherein said first target of said multitarget alignment mark is constructed in a first layer of material of said work piece, and said second target of said multitarget alignment mark is constructed in a second layer of material of said work piece.

30. An alignment system according to claim 23, wherein said first target of said multitarget alignment mark is a diffraction order enhancing grating that enhances a first diffraction order of radiation diffracted therefrom compared to a purely periodic grating, and said second target of said multitarget alignment mark is a diffraction order enhancing grating that enhances a second diffraction order of radiation diffracted therefrom compared to a purely periodic grating, said first diffraction order being an integer value different from an integer value of said second diffraction order.

31. An alignment system according to claim 1, wherein said detection system further comprises a third detector channel, and said position determining unit is constructed to process information from said first, second and third detector channels in a combination to determine said position of said alignment mark on said work piece while performing at least one of a calibration and a qualification.

32. A lithographic projection apparatus, comprising:

an illumination system adapted to provide illumination radiation;

a substrate stage assembly adapted to be disposed in a path of said illumination radiation;

a reticle stage assembly arranged in said path of said illumination radiation between said illumination system and said substrate stage assembly;

a projection system arranged between said reticle stage assembly and said substrate stage assembly; and

an alignment system arranged proximate at least one of said substrate stage assembly and said reticle stage assembly,

wherein said alignment system comprises:

a source of alignment radiation;

a detection system comprising a first detector channel and a second detector channel; and

a position determining unit in communication with said detection system,

wherein said position determining unit is constructed to process information from said first and second detector channels in a combination to determine a position of an alignment mark on a work piece, said combination taking into account a manufacturing process of said work piece.

33. A lithographic projection apparatus according to claim 32, wherein said first detector channel is a first non-zero-diffraction-order channel, and said second detector channel is a second non-zero-diffraction-order channel.

34. A lithographic projection apparatus according to claim 33, wherein said position determining unit is constructed to process said information from said first and second non-zero-diffraction-order channels by weighting first and second signals from said first and second non-zero-diffraction-order channels with factors that depend on a relative strength of said first signal to said second signal.

35. A lithographic projection apparatus according to claim 34, wherein the weight factor for said second non-zero-diffraction-order channel is set to

zero when a strength of said first signal relative to said second signal exceeds a predetermined threshold.

36. A lithographic projection apparatus according to claim 32, wherein said position determining unit is constructed to process information from said first and second detector channels in a combination to determine a position of said alignment mark on said work piece with a first precision.

37. A lithographic projection apparatus according to claim 36, wherein said position determining unit is constructed to process information from third and fourth detector channels to determine a position of said alignment mark on said work piece with a second precision that is more precise than said first precision.

38. A lithographic projection apparatus according to claim 32, wherein said position determining unit is constructed to process said information from said first and second detector channels by weighting first and second signals from said first and second detector channels equally.

39. A lithographic projection apparatus according to claim 32, wherein said position determining unit is constructed to process said information from said first and second detector channels by weighting first and second signals from said first and second detector channels with factors that depend on at least one measurable quantity selected from the set of measurable quantities consisting of mcc, minirepro, signal-to-noise ratio, signal shape, signal envelope, focus, tilt, order channels position offset, wavelength channels position offset, shift between segments and coarse-fine position deviation,

wherein the parameter mcc is a multiple correlation coefficient indicating how well the measured signal resembles the signal expected for a perfect alignment mark, minirepro is a standard deviation of the aligned position of different sections or portions of an alignment measurement

indicating the accuracy of the aligned position, signal to noise ratio is the fitted signal divided by the relative level of noise across the spectrum of the measured signal, while the signal shape is the relative level of a few discrete frequencies in this spectrum, generally at multiples of the base frequency, the signal envelope is variance of the signal strength during the measurement, the focus is the offset in wafer height during the measurement, the tilt is the angle between the wafer angle and the detector angle during the measurement, order channels position offset is the measured difference in aligned position of the various channels of one wavelength, the wavelength channels position offset is the measured difference in aligned position of the various wavelength channels, the shift between segments is the measured difference in aligned position of the various segments of a multi segmented alignment mark, and the coarse-fine position deviation is the difference between the position of the alignment marks in the fine phase with respect to their expected position based on alignment mark measurements in the coarse phase.

40. A lithographic projection apparatus according to claim 32, wherein said position determining unit determines said position of said alignment mark by a predictive recipe using said combined information from said first and second detector channels.

41. A lithographic projection apparatus according to claim 40, wherein said predictive recipe is a static predictive based on a fixed data set.

42. A lithographic projection apparatus according to claim 40, wherein said predictive recipe is based on an initial data set that may be modified during said determining said position of said alignment mark on said work piece.

43. A lithographic projection apparatus according to claim 41, wherein said fixed data set include a dependence of a position of said alignment mark on said work piece.

44. A lithographic projection apparatus according to claim 40, wherein said predictive recipe includes fitting a continuous function to at least said position of said alignment mark determined from combined information from said first and second detector channels.

45. A lithographic projection apparatus according to claim 40, wherein said predictive recipe predicts a position of an alignment mark with substantially zero systematic processing-induced error.

46. A lithographic projection apparatus according to claim 45, wherein said substantially zero systematic processing-induced error corresponds to systematic errors introduced by a chemical mechanical polishing process.

47. A lithographic projection apparatus according to claim 45, wherein said substantially zero systematic processing-induced error corresponds to systematic errors introduced by a copper damascene process.

48. A lithographic projection apparatus according to claim 32, wherein said position determining unit is constructed to determine said position of said alignment mark by including information from an alignment mark detected on a second work piece.

49. A lithographic projection apparatus according to claim 32, wherein said first detector channel is a first wavelength channel, and said second detector channel is a second wavelength channel.

50. A lithographic projection apparatus according to claim 32, wherein said source of alignment radiation comprises a laser providing illumination radiation at a first wavelength.

51. A lithographic projection apparatus according to claim 50, wherein said source of alignment radiation further comprises a second laser providing illumination radiation at a second wavelength.

52. A lithographic projection apparatus according to claim 32, wherein said source of alignment radiation comprises a broadband source adapted to provide illumination radiation at a plurality of wavelengths.

53. A lithographic projection apparatus according to claim 32, wherein said detection system comprises a first detector constructed to provide a first detection signal to said first detector channel, and a second detector constructed to provide a second detection signal to said second detector channel.

54. A lithographic projection apparatus according to claim 32, wherein said detection system is constructed to detect a first target of a multitarget alignment mark and a second target of said multitarget alignment mark.

55. A lithographic projection apparatus according to claim 54, wherein said first target of said multitarget alignment mark includes at least one of a structure above or below a portion of said first target.

56. A lithographic projection apparatus according to claim 54, wherein said detection system is constructed to detect a first target of a multitarget alignment mark to provide said first detection signal, and said detection system is constructed to detect a second target of said multitarget alignment mark to provide said second detection signal.

57. A lithographic projection apparatus according to claim 54, wherein said first target of said multitarget alignment mark is a process target that is constructed to undergo predetermined changes during said manufacturing process of said work piece.

58. A lithographic projection apparatus according to claim 57, wherein said second target of said multitarget alignment mark is constructed to undergo less changes during said manufacturing process of said work piece than said first target to provide a robust backup target to said first target.

59. A lithographic projection apparatus according to claim 54, wherein said first target of said multitarget alignment mark is a sacrificial target that is constructed to be destroyed during said manufacturing process of said work piece.

60. A lithographic projection apparatus according to claim 56, wherein said first target of said multitarget alignment mark is constructed in a first layer of material of said work piece, and said second target of said multitarget alignment mark is constructed in a second layer of material of said work piece.

61. A lithographic projection apparatus according to claim 56, wherein said first target of said multitarget alignment mark is a diffraction order enhancing grating that enhances a first diffraction order of radiation diffracted therefrom compared to a purely periodic grating, and said second target of said multitarget alignment mark is a diffraction order enhancing grating that enhances a second diffraction order of radiation diffracted therefrom compared to a purely periodic grating, said first diffraction order being an integer value different from an integer value of said second diffraction order.

62. A lithographic projection apparatus according to claim 32, wherein said detection system further comprises a third detector channel, and said position determining unit is constructed to process information from said first, second and third detector channels in a combination to determine said position of said alignment mark on said work piece while performing at least one of a calibration and a qualification.

63. A method of aligning a workpiece for the manufacture of a microdevice, comprising:

forming an alignment mark on said workpiece;

detecting said alignment mark with an alignment system;

receiving a first signal from said alignment system in response to said alignment mark;

receiving a second signal from said alignment system in response to said alignment mark; and

determining a position of said alignment mark on said workpiece based on information from said first and second signals combined according to processing said workpiece had undergone.

64. A method of aligning a workpiece according to claim 63, wherein said alignment mark is a multitarget alignment mark, said first signal is in response to a first target of said multitarget alignment mark, and said second signal is in response to a second target of said multitarget alignment mark.

65. A method of aligning a workpiece according to claim 63, wherein said alignment system comprises a first detector that produces said first signal and a second detector that produces said second signal, said first and second signals being produced substantially simultaneously.

66. A method of aligning a workpiece according to claim 65, wherein said alignment mark is a multitarget alignment mark, said first signal is in response to a first target of said multitarget alignment mark, and said second signal is in response to a second target of said multitarget alignment mark.

67. A method of aligning a workpiece according to claim 63, further comprising determining a position of a fiducial mark on a stage assembly that is adapted to hold said workpiece and determining said position of said alignment mark relative to said fiducial mark.

68. A method of aligning a workpiece according to claim 63, wherein said multi-target alignment mark is formed along a scribeline on said workpiece between adjacent micro-device regions.

69. A method of aligning a workpiece according to claim 64, wherein said first target is a first diffraction grating and said second target is a second diffraction grating.

70. A method of aligning a workpiece according to claim 69, wherein said first and second diffraction gratings are diffraction-order-enhancing gratings.

71. A method of aligning a workpiece according to claim 64, wherein said first target has a different pattern than said second target.

72. A method of aligning a workpiece according to claim 64, wherein said first target has a substructure constructed based on a structure of said micro-device.

73. A method of aligning a workpiece according to claim 64, wherein said detecting said multitarget alignment mark comprises illuminating said multitarget alignment mark with an alignment beam of radiation.

74. A method of aligning a workpiece according to claim 65, wherein said first signal received from said first detector of said alignment system corresponds to detecting a first pair of non-zero order diffracted beams of alignment radiation after said alignment beam of radiation illuminates said first target, and

said second signal received from said second detector of said alignment system corresponds to detecting a second pair of non-zero order diffracted beams of alignment radiation after said alignment beam of radiation illuminates said second target, said first and second pairs of non-zero-order diffracted beams being different orders from each other.

75. A method of aligning a workpiece according to claim 63, wherein said determining said position of said alignment mark comprises predicting a position based on said first and second signals.

76. A method of capturing an alignment mark on a workpiece for the manufacture of a microdevice within a measurement region, comprising:

forming a multi-grating alignment mark on said workpiece;

detecting said multi-grating alignment mark with an alignment system having a plurality of detectors;

selecting first and second gratings out of a plurality of gratings from said multi-grating alignment mark;

comparing a first substantially periodic signal from said first grating of said multi-grating alignment mark from a first one of said plurality of detectors to a second substantially periodic signal from said second grating of said multi-grating alignment mark from a second one of said plurality of detectors; and

determining a capture range based on said comparing.

77. A method of capturing an alignment mark according to claim 76, wherein said first grating is a diffraction-order-enhancing grating that enhances an order greater than first order and said second grating is a diffraction-order-enhancing grating that enhances an order greater than first order.

78. A method of capturing an alignment mark according to claim 77, wherein said first and second diffraction-order-enhancing gratings of said multi-grating alignment mark enhance different diffraction orders.

79. An alignment mark for use in the manufacture of a micro-device, comprising:

a first target having a first detection pattern; and

a second target having a second detection pattern,

wherein said first target is adapted to be detected by a first detector, and

said second target is adapted to be detected by a second detector.

80. An alignment mark according to claim 79,

wherein said first target is a first diffraction-order-enhancing grating having a first periodic grating pattern, and

said second target is a second diffraction-order-enhancing grating having a second periodic grating pattern, said first target enhancing a diffracted beam of a different order from a diffracted beam enhanced by said second target.

81. An alignment mark according to claim 80,

further comprising a third target having a third detection pattern,

wherein said third target is a third diffraction-order-enhancing grating having a third periodic grating pattern, said third target enhancing a diffracted beam of a different order from said diffracted beams enhanced by said first and second targets.

82. An alignment mark according to claim 81, further comprising a fourth target having a fourth detection pattern,

wherein said fourth target is a diffraction grating having a periodic pattern of a different period from said first, second and third periodic grating patterns.

83. A diffraction-order-enhancing alignment mark formed on an object for use in the manufacture of a micro-device that enhances a strength of a diffracted beam of non-zero order.

84. An alignment mark formed on an object for use in manufacture of a microdevice, comprising a target having a detection pattern and a processing pattern, wherein said processing pattern has a structure that changes under microdevice processing in correspondence with changes to said microdevice during manufacture.

85. A method of automatic process control for the manufacture of microdevices, comprising:

receiving data from an alignment mark detection system having a plurality of detector channels;

determining an updated processing strategy based on said received data from said alignment mark detection system; and

altering a processing step based on said updated processing strategy,

wherein said plurality of detector channels of said alignment mark detection system provide a corresponding plurality of signals substantially simultaneously during detection of an alignment mark.

86. A method of automatic process control according to claim 85, wherein said data from said alignment mark detection system is obtained from a scan of a multitarget alignment mark.

87. A method of automatic process control according to claim 86, wherein said multitarget alignment mark comprises at least two targets separately detectable by said alignment mark detection system to provide detection signals in corresponding at least two detector channels of said plurality of detector channels.

88. A method of automatic process control according to claim 87, wherein said at least two targets are each diffraction-order-enhancing gratings that enhance different diffraction orders, the corresponding at least two detector channels being diffraction-order channels.

89. A method of automatic process control according to claim 86, wherein at least one of said at least two targets of said multitarget alignment mark is a process target that changes a signal characteristic in a substantially predictable manner during steps of processing said microdevice.

90. A method of automatic process control according to claim 89, wherein said process target is a diffraction grating having a substructure of cross trenches filled with tungsten.

91. A method of automatic process control according to claim 87, wherein at least one of said at least two targets of said multitarget alignment mark is a diffraction grating formed over a layer of material opaque to alignment radiation directed thereon, said layer of opaque material acting to tune an effective depth of said diffraction grating.

92. A method of automatic process control according to claim 86, wherein said multitarget alignment mark comprises at least four targets formed along a scribe line of a semiconductor wafer.

93. A method of automatic process control according to claim 85, wherein said alignment mark detection system is an off-axial alignment system of a lithographic exposure apparatus.

94. A method of automatic process control according to claim 93, further comprising:

receiving data from an off-line metrology tool; and

determining said updated processing strategy based on said received data from said alignment mark detection system and said data from said off-line metrology tool.

95. A method of automatic process control according to claim 85, wherein at least two channels of said plurality of detector channels correspond to detection at different wavelengths.

96. An automatic process control system for the manufacture of microdevices, comprising:

a data processing unity adapted to receive data from an alignment mark detection system having a plurality of detector channels,

wherein said data processing unit determines an updated processing strategy based on data received from said alignment mark detection system and outputs a signal to alter a processing step based on said updated processing strategy, and

wherein said plurality of detector channels of said alignment mark detection system provide a corresponding plurality of signals substantially simultaneously during detection of an alignment mark.

97. An automatic process control system according to claim 96, wherein said data from said alignment mark detection system is obtained during a scan of a multitarget alignment mark.

98. An automatic process control system according to claim 97, wherein said multitarget alignment mark comprises at least two targets

separately detectable by said alignment mark detection system to provide detection signals in corresponding at least two detector channels of said plurality of detector channels.

99. An automatic process control system according to claim 98, wherein said at least two targets are each diffraction-order-enhancing gratings that enhance different diffraction orders, the corresponding at least two detector channels being diffraction-order channels.

100. An automatic process control system according to claim 98, wherein at least one of said at least two targets of said multitarget alignment mark is a process target that changes a signal characteristic in a substantially predictable manner during steps of processing said microdevice.

101. An automatic process control system according to claim 100, wherein said process target is a diffraction grating having a substructure of cross trenches filled with tungsten.

102. An automatic process control system according to claim 98, wherein at least one of said at least two targets of said multitarget alignment mark is a diffraction grating formed over a layer of material opaque to alignment radiation directed thereon, said layer of opaque material acting to tune an effective depth of said diffraction grating.

103. An automatic process control system according to claim 97, wherein said multitarget alignment mark comprises at least four targets formed along a scribe line of a semiconductor wafer.

104. An automatic process control system according to claim 96, wherein said alignment mark detection system is an off-axial alignment system of a lithographic exposure apparatus.

105. An automatic process control system according to claim 104, wherein said data processing unit is further adapted to receive data from an off-line metrology tool, and said data processing unit determines said updated processing strategy based on data received from said alignment mark detection system and said off-line metrology tool and outputs said signal to alter said processing step based on said updated processing strategy.

106. An automatic process control system according to claim 96, wherein at least two channels of said plurality of detector channels correspond to detection at different wavelengths.

107. A method of automatic equipment control for the manufacture of microdevices, comprising:

receiving data from an alignment mark detection system having a plurality of detector channels;

determining an updated processing strategy based on said received data from said alignment mark detection system; and

altering a processing step based on said updated processing strategy,

wherein said plurality of detector channels of said alignment mark detection system provide a corresponding plurality of signals substantially simultaneously during detection of an alignment mark.

108. A method of automatic equipment control according to claim 107, wherein said data from said alignment mark detection system is obtained during a scan of a multitarget alignment mark.

109. A method of automatic equipment control according to claim 108, wherein said multitarget alignment mark comprises at least two targets separately detectable by said alignment mark detection system to provide

detection signals in corresponding at least two detector channels of said plurality of detector channels.

110. A method of automatic equipment control according to claim 109, wherein said at least two targets are each diffraction-order-enhancing gratings that enhance different diffraction orders, the corresponding at least two detector channels being diffraction-order channels.

111. A method of automatic equipment control according to claim 110, wherein at least one of said at least two targets of said multitarget alignment mark is a process target that changes a signal characteristic in a substantially predictable manner during steps of processing said microdevice.

112. A method of automatic equipment control according to claim 111, wherein said process target is a diffraction grating having a substructure of cross trenches filled with tungsten.

113. A method of automatic equipment control according to claim 109, wherein at least one of said at least two targets of said multitarget alignment mark is a diffraction grating formed over a layer of material opaque to alignment radiation directed thereon, said layer of opaque material acting to tune an effective depth of said diffraction grating.

114. A method of automatic equipment control according to claim 108, wherein said multitarget alignment mark comprises at least four targets formed along a scribe line of a semiconductor wafer.

115. A method of automatic equipment control according to claim 107, wherein said alignment mark detection system is an off-axial alignment system of a lithographic exposure apparatus.

116. A method of automatic equipment control according to claim 107, wherein at least two channels of said plurality of detector channels correspond to detection at different wavelengths.

117. An alignment system for a lithographic apparatus, comprising:

a source of alignment radiation;

a detection system comprising a first detector channel and a second detector channel; and

a position determining unit in communication with said detection system,

wherein said position determining unit is constructed to process information from said first and second detector channels in a combination to determine an alignment grid for a work piece.

118. An alignment system according to claim 117, wherein said first detector channel is a first non-zero-diffraction-order channel, and said second detector channel is a second non-zero-diffraction-order channel.

119. An alignment system according to claim 118, wherein said position determining unit is constructed to process said information from said first and second non-zero-diffraction-order channels by weighting first and second signals from said first and second non-zero-diffraction-order channels with factors that depend on a relative strength of said first signal to said second signal.

120. An alignment system according to claim 119, wherein the weight factor for said second non-zero-diffraction-order channel is set to zero when a strength of said first signal relative to said second signal exceeds a predetermined threshold.

121. An alignment system according to claim 117, wherein said position determining unit is constructed to process information from said first and second detector channels in a combination to determine said alignment grid with a first precision.

122. An alignment system according to claim 121, wherein said position determining unit is constructed to process information from third and fourth detector channels to determine an alignment grid with a second precision that is more precise than said first precision.

123. An alignment system according to claim 117, wherein said position determining unit is constructed to process said information from said first and second detector channels by weighting first and second signals from said first and second detector channels equally.

124. An alignment system according to claim 117, wherein said position determining unit is constructed to process said information from said first and second detector channels by weighting first and second signals from said first and second detector channels with factors that depend on at least one measurable quantity selected from the set of measurable quantities consisting of mcc, minirepro, signal-to-noise ratio, signal shape, signal envelope, focus, tilt, order channels position offset, wavelength channels position offset, shift between segments and coarse-fine position deviation,

wherein the parameter mcc is a multiple correlation coefficient indicating how well the measured signal resembles the signal expected for a perfect alignment mark, minirepro is a standard deviation of the aligned position of different sections or portions of an alignment measurement indicating the accuracy of the aligned position, signal to noise ratio is the fitted signal divided by the relative level of noise across the spectrum of the measured signal, while the signal shape is the relative level of a few discrete frequencies in this spectrum, generally at multiples of the base frequency, the

signal envelope is variance of the signal strength during the measurement, the focus is the offset in wafer height during the measurement, the tilt is the angle between the wafer angle and the detector angle during the measurement, order channels position offset is the measured difference in aligned position of the various channels of one wavelength, the wavelength channels position offset is the measured difference in aligned position of the various wavelength channels, the shift between segments is the measured difference in aligned position of the various segments of a multi segmented alignment mark, and the coarse-fine position deviation is the difference between the position of the alignment marks in the fine phase with respect to their expected position based on alignment mark measurements in the coarse phase.

125. An alignment system according to claim 117, wherein said position determining unit is constructed to determine said alignment grid by a predictive recipe using said combined information from said first and second detector channels.

126. An alignment system according to claim 125, wherein said predictive recipe is a static predictive recipe based on a fixed data set.

127. An alignment system according to claim 125, wherein said predictive recipe is based on an initial data set that may be modified during said determining said alignment grid.

128. An alignment system according to claim 126, wherein said fixed data set includes a dependence on a position of said alignment mark on said work piece.

129. An alignment system according to claim 117, wherein said position determining unit is constructed to determine said alignment grid by including information from an alignment grid determined on a second work piece.

130. An alignment system according to claim 117, wherein said first detector channel is a first wavelength channel, and said second detector channel is a second wavelength channel.

131. An alignment system according to claim 117, wherein said source of alignment radiation comprises a laser providing illumination radiation at a first wavelength.

132. An alignment system according to claim 125, wherein said source of alignment radiation further comprises a second laser providing illumination radiation at a second wavelength.

133. An alignment system according to claim 117, wherein said source of alignment radiation comprises a broadband source adapted to provide illumination radiation at a plurality of wavelengths.

134. An alignment system according to claim 117, wherein said detection system comprises a first detector constructed to provide a first detection signal to said first detector channel, and a second detector constructed to provide a second detection signal to said second detector channel.

135. An alignment system according to claim 117, wherein said detection system is constructed to detect a first target of a multitarget alignment mark and a second target of said multitarget alignment mark.

136. An alignment system according to claim 135, wherein said first target of said multitarget alignment mark includes at least one of a structure above or below a portion of said first target.

137. An alignment system according to claim 135, wherein said detection system is constructed to detect a first target of a multitarget alignment mark to provide said first detection signal, and said detection

system is constructed to detect a second target of said multitarget alignment mark to provide said second detection signal.

138. An alignment system according to claim 135, wherein said first target of said multitarget alignment mark is a process target that is constructed to undergo predetermined changes during said manufacturing process of said work piece.

139. An alignment system according to claim 138, wherein said second target of said multitarget alignment mark is constructed to undergo less changes during said manufacturing process of said work piece than said first target to provide a robust backup target to said first target.

140. An alignment system according to claim 135, wherein said first target of said multitarget alignment mark is a sacrificial target that is constructed to be destroyed during said manufacturing process of said work piece.

141. An alignment system according to claim 135, wherein said first target of said multitarget alignment mark is constructed in a first layer of material of said work piece, and said second target of said multitarget alignment mark is constructed in a second layer of material of said work piece.

142. An alignment system according to claim 135, wherein said first target of said multitarget alignment mark is a diffraction order enhancing grating that enhances a first diffraction order of radiation diffracted therefrom compared to a purely periodic grating, and said second target of said multitarget alignment mark is a diffraction order enhancing grating that enhances a second diffraction order of radiation diffracted therefrom compared to a purely periodic grating, said first diffraction order being an integer value different from an integer value of said second diffraction order.

143. An alignment system according to claim 117, wherein said detection system further comprises a third detector channel, and said position determining unit is constructed to process information from said first, second and third detector channels in a combination to determine said alignment grid while performing at least one of a calibration and a qualification.

144. A lithographic projection apparatus, comprising:

an illumination system adapted to provide illumination radiation;

a substrate stage assembly adapted to be disposed in a path of said illumination radiation;

a reticle stage assembly arranged in said path of said illumination radiation between said illumination system and said substrate stage assembly;

a projection system arranged between said reticle stage assembly and said substrate stage assembly; and

an alignment system arranged proximate at least one of said substrate stage assembly and said reticle stage assembly,

wherein said alignment system comprises:

a source of alignment radiation;

a detection system comprising a first detector channel and a second detector channel; and

a position determining unit in communication with said detection system,

wherein said position determining unit is constructed to process information from said first and second detector channels in a combination to determine an alignment grid for a work piece.

145. A lithographic projection apparatus according to claim 144, wherein said first detector channel is a first non-zero-diffraction-order channel, and said second detector channel is a second non-zero-diffraction-order channel.

146. A lithographic projection apparatus according to claim 145, wherein said position determining unit is constructed to process said information from said first and second non-zero-diffraction-order channels by weighting first and second signals from said first and second non-zero-diffraction-order channels with factors that depend on a relative strength of said first signal to said second signal.

147. A lithographic projection apparatus according to claim 146, wherein the weight factor for said second non-zero-diffraction-order channel is set to zero when a strength of said first signal relative to said second signal exceeds a predetermined threshold.

148. A lithographic projection apparatus according to claim 144, wherein said position determining unit is constructed to process information from said first and second detector channels in a combination to determine an alignment grid for said work piece with a first precision.

149. A lithographic projection apparatus according to claim 148, wherein said position determining unit is constructed to process information from third and fourth detector channels to determine said alignment grid for said work piece with a second precision that is more precise than said first precision.

150. A lithographic projection apparatus according to claim 144, wherein said position determining unit is constructed to process said information from said first and second detector channels by weighting first and second signals from said first and second detector channels equally.

151. A lithographic projection apparatus according to claim 144, wherein said position determining unit is constructed to process said information from said first and second detector channels by weighting first and second signals from said first and second detector channels with factors that depend on at least one measurable quantity selected from the set of measurable quantities consisting of mcc, minirepro, signal-to-noise ratio, signal shape, signal envelope, focus, tilt, order channels position offset, wavelength channels position offset, shift between segments and coarse-fine position deviation,

wherein the parameter mcc is a multiple correlation coefficient indicating how well the measured signal resembles the signal expected for a perfect alignment mark, minirepro is a standard deviation of the aligned position of different sections or portions of an alignment measurement indicating the accuracy of the aligned position, signal to noise ratio is the fitted signal divided by the relative level of noise across the spectrum of the measured signal, while the signal shape is the relative level of a few discrete frequencies in this spectrum, generally at multiples of the base frequency, the signal envelope is variance of the signal strength during the measurement, the focus is the offset in wafer height during the measurement, the tilt is the angle between the wafer angle and the detector angle during the measurement, order channels position offset is the measured difference in aligned position of the various channels of one wavelength, the wavelength channels position offset is the measured difference in aligned position of the various wavelength channels, the shift between segments is the measured difference in aligned position of the various segments of a multi segmented alignment mark, and the coarse-fine position deviation is the difference between the position of the alignment marks in the fine phase with respect to their expected position based on alignment mark measurements in the coarse phase.

152. A lithographic projection apparatus according to claim 144, wherein said position determining unit determines said position of said alignment mark by a predictive recipe using said combined information from said first and second detector channels.

153. A lithographic projection apparatus according to claim 152, wherein said predictive recipe is a static predictive based on a fixed data set.

154. A lithographic projection apparatus according to claim 152, wherein said predictive recipe is based on an initial data set that may be modified during said determining said position of said alignment mark on said work piece.

155. A lithographic projection apparatus according to claim 153, wherein said fixed data set includes a dependence on a position of said alignment mark on said work piece.

156. A lithographic projection apparatus according to claim 144, wherein said position determining unit is constructed to determine said alignment grid by including information from an alignment grid determined on a second work piece.

157. A lithographic projection apparatus according to claim 144, wherein said first detector channel is a first wavelength channel, and said second detector channel is a second wavelength channel.

158. A lithographic projection apparatus according to claim 144, wherein said source of alignment radiation comprises a laser providing illumination radiation at a first wavelength.

159. A lithographic projection apparatus according to claim 158, wherein said source of alignment radiation further comprises a second laser providing illumination radiation at a second wavelength.

160. A lithographic projection apparatus according to claim 144, wherein said source of alignment radiation comprises a broadband source adapted to provide illumination radiation at a plurality of wavelengths.

161. A lithographic projection apparatus according to claim 144, wherein said detection system comprises a first detector constructed to provide a first detection signal to said first detector channel, and a second detector constructed to provide a second detection signal to said second detector channel.

162. A lithographic projection apparatus according to claim 144, wherein said detection system is constructed to detect a first target of a multitarget alignment mark and a second target of said multitarget alignment mark.

163. A lithographic projection apparatus according to claim 162, wherein said first target of said multitarget alignment mark includes at least one of a structure above or below a portion of said first target.

164. A lithographic projection apparatus according to claim 162, wherein said detection system is constructed to detect a first target of a multitarget alignment mark to provide said first detection signal, and said detection system is constructed to detect a second target of said multitarget alignment mark to provide said second detection signal.

165. A lithographic projection apparatus according to claim 162, wherein said first target of said multitarget alignment mark is a process target that is constructed to undergo predetermined changes during said manufacturing process of said work piece.

166. A lithographic projection apparatus according to claim 165, wherein said second target of said multitarget alignment mark is constructed to

undergo less changes during said manufacturing process of said work piece than said first target to provide a robust backup target to said first target.

167. A lithographic projection apparatus according to claim 162, wherein said first target of said multitarget alignment mark is a sacrificial target that is constructed to be destroyed during said manufacturing process of said work piece.

168. A lithographic projection apparatus according to claim 164, wherein said first target of said multitarget alignment mark is constructed in a first layer of material of said work piece, and said second target of said multitarget alignment mark is constructed in a second layer of material of said work piece.

169. A lithographic projection apparatus according to claim 164, wherein said first target of said multitarget alignment mark is a diffraction order enhancing grating that enhances a first diffraction order of radiation diffracted therefrom compared to a purely periodic grating, and said second target of said multitarget alignment mark is a diffraction order enhancing grating that enhances a second diffraction order of radiation diffracted therefrom compared to a purely periodic grating, said first diffraction order being an integer value different from an integer value of said second diffraction order.

170. A lithographic projection apparatus according to claim 144, wherein said detection system further comprises a third detector channel, and said position determining unit is constructed to process information from said first, second and third detector channels in a combination to determine said alignment grid for said work piece while performing at least one of a calibration and a qualification.

171. A method of aligning a workpiece for the manufacture of a microdevice, comprising:

forming an alignment mark on said workpiece;

detecting said alignment mark with an alignment system;

receiving a first signal from said alignment system in response to said alignment mark;

receiving a second signal from said alignment system in response to said alignment mark; and

determining an alignment grid for said workpiece based on information from said first and second signals.

172. A method of aligning a workpiece according to claim 171, wherein said alignment mark is a multitarget alignment mark, said first signal is in response to a first target of said multitarget alignment mark, and said second signal is in response to a second target of said multitarget alignment mark.

173. A method of aligning a workpiece according to claim 171, wherein said alignment system comprises a first detector that produces said first signal and a second detector that produces said second signal.

174. A method of aligning a workpiece according to claim 173, wherein said alignment mark is a multitarget alignment mark, said first signal is in response to a first target of said multitarget alignment mark, and said second signal is in response to a second target of said multitarget alignment mark.

175. A method of aligning a workpiece according to claim 171, further comprising determining a position of a fiducial mark on a stage assembly that

is adapted to hold said workpiece and determining said position of said alignment mark relative to said fiducial mark.

176. A method of aligning a workpiece according to claim 171, wherein said multi-target alignment mark is formed along a scribeline on said workpiece between adjacent micro-device regions.

177. A method of aligning a workpiece according to claim 172, wherein said first target is a first diffraction grating and said second target is a second diffraction grating.

178. A method of aligning a workpiece according to claim 177, wherein said first and second diffraction gratings are diffraction-order-enhancing gratings.

179. A method of aligning a workpiece according to claim 172, wherein said first target has a different pattern than said second target.

180. A method of aligning a workpiece according to claim 172, wherein said first target has a substructure constructed based on a structure of said micro-device.

181. A method of aligning a workpiece according to claim 172, wherein said detecting said multitarget alignment mark comprises illuminating said multitarget alignment mark with an alignment beam of radiation.

182. A method of aligning a workpiece according to claim 173, wherein said first signal received from said first detector of said alignment system corresponds to detecting a first pair of non-zero order diffracted beams of alignment radiation after said alignment beam of radiation illuminates said first target, and

said second signal received from said second detector of said alignment system corresponds to detecting a second pair of non-zero order diffracted beams of alignment radiation after said alignment beam of radiation illuminates said second target, said first and second pairs of non-zero-order diffracted beams being different orders from each other.

183. A method of aligning a workpiece according to claim 171, wherein said determining said position of said alignment mark comprises predicting a position based on said first and second signals.

184. A metrology system for a lithographic apparatus, comprising:

a source of alignment radiation;

a detection system comprising a first detector channel and a second detector channel; and

a processing unit in communication with said detection system,

wherein said processing unit is constructed to process information from said first and second detector channels in a combination to determine at least one of a focus, energy, dose, line width, contact hole width or critical dimension based on detecting an alignment mark on a work piece.

185. A metrology system according to claim 184, wherein said first detector channel is a first non-zero-diffraction-order channel, and said second detector channel is a second non-zero-diffraction-order channel.

186. A metrology system according to claim 185, wherein said processing unit is constructed to process said information from said first and second non-zero-diffraction-order channels by weighting first and second signals from said first and second non-zero-diffraction-order channels with

factors that depend on a relative strength of said first signal to said second signal.

187. A metrology system according to claim 186, wherein the weight factor for said second non-zero-diffraction-order channel is set to zero when a strength of said first signal relative to said second signal exceeds a predetermined threshold.

188. A metrology system according to claim 184, wherein said first detector channel is a first wavelength channel, and said second detector channel is a second wavelength channel.

189. A metrology system according to claim 184, wherein said source of alignment radiation comprises a laser providing illumination radiation at a first wavelength.

190. A metrology system according to claim 189, wherein said source of alignment radiation further comprises a second laser providing illumination radiation at a second wavelength.

191. A metrology system according to claim 184, wherein said source of alignment radiation comprises a broadband source adapted to provide illumination radiation at a plurality of wavelengths.

192. A metrology system according to claim 184, wherein said detection system comprises a first detector constructed to provide a first detection signal to said first detector channel, and a second detector constructed to provide a second detection signal to said second detector channel.

193. A metrology system according to claim 184, wherein said detection system is constructed to detect a first target of a multitarget alignment mark and a second target of said multitarget alignment mark.

194. A metrology system according to claim 193, wherein said first target of said multitarget alignment mark includes at least one of a structure above or below a portion of said first target.

195. A metrology system according to claim 193, wherein said detection system is constructed to detect a first target of a multitarget alignment mark to provide said first detection signal, and said detection system is constructed to detect a second target of said multitarget alignment mark to provide said second detection signal.

196. A metrology system according to claim 193, wherein said first target of said multitarget alignment mark is a process target that is constructed to undergo predetermined changes during a manufacturing process of said work piece.

197. A metrology system according to claim 196, wherein said second target of said multitarget alignment mark is constructed to undergo less changes during said manufacturing process of said work piece than said first target to provide a robust backup target to said first target.

198. A metrology system according to claim 193, wherein said first target of said multitarget alignment mark is a sacrificial target that is constructed to be destroyed during a manufacturing process of said work piece.

199. A metrology system according to claim 193, wherein said first target of said multitarget alignment mark is constructed in a first layer of material of said work piece, and said second target of said multitarget alignment mark is constructed in a second layer of material of said work piece.

200. A metrology system according to claim 193, wherein said first target of said multitarget alignment mark is a diffraction order enhancing grating that enhances a first diffraction order of radiation diffracted therefrom

compared to a purely periodic grating, and said second target of said multitarget alignment mark is a diffraction order enhancing grating that enhances a second diffraction order of radiation diffracted therefrom compared to a purely periodic grating, said first diffraction order being an integer value different from an integer value of said second diffraction order.

201. A metrology system according to claim 184, wherein said detection system further comprises a third detector channel, and said processing unit is constructed to process information from said first, second and third detector channels in a combination to determine at least one of said focus, energy, dose, line width, contact hole width or critical dimension while performing at least one of a calibration and a qualification.

202. A lithographic apparatus, comprising:

an illumination system;

a substrate stage assembly arranged in a radiation path of illumination radiation from said illumination system;

a reticle stage assembly arranged in said radiation path of said illumination radiation between said illumination system and said substrate stage assembly;

a projection system arranged between said reticle stage assembly and said substrate stage assembly; and

an alignment system arranged proximate at least one of said substrate stage assembly and said reticle stage assembly,

wherein said alignment system comprises:

a source of alignment radiation;

a detection system comprising a first detector channel and a second detector channel; and

a position determining unit in communication with said detection system,

wherein said position determining unit is constructed to process information from said first and second detector channels in a combination to determine a position of an alignment mark on a work piece, said combination taking into account a manufacturing process of said work piece.